DEPARTMENT OF THE NAVY

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

WASHINGTON D C 20363 5100

IN REPLY REFER TO

3960
Ser PMW 165-12/802
13 OCT 92

From: Commander, Space and Naval Warfare Systems Command
To: Chief of Naval Operations (N096)

Subj: SHIPBOARD METEOROLOGICAL AND OCEANOGRAPHIC OBSERVING SYSTEM (SMOOS) DEVELOPMENT TESTING

Ref: (a) SPAWARINST 3960.3D

Encl: (1) SMOOS Technical Evaluation Report

1. Enclosure (1) is forwarded for information. The SMOOS developmental testing reported herein was conducted in accordance with reference (a). This report will be used internally in SPAWAR as the basis for a MILESTONE III decision on SMOOS.

2. Our point of contact is Mr. Joe Miller, PMW 165-12, telephone (703) 602-3187.

C. W. HOFFMAN
By direction

Copy to:
COMNAVOCEANCOM
NAVEASTOCEANCEN (LTJG Berger)
NAVOCEANO
NRL Monterey
NAVELEXCEN Vallejo
DTIC

DEVELOPMENTAL TEST REPORT
OF THE
SHIPBOARD METEOROLOGICAL AND OCEANOGRAPHIC OBSERVING SYSTEM
(SMOOS)

SYSTEM: SMOOS (AN/UMK-3)
DT PHASE: DEVELOPMENTAL TEST (DT-IIE) 7 August to 21 August 1992
Ref: (a) SMOOS Temp No. 1162 of 17 May 90

1. Purpose. DEVELOPMENTAL TEST (DT-IIE) was conducted to determine the operational effectiveness and suitability of the SMOOS sensors in an operational environment in preparation for a MILESTONE III decision.

2. Equipment/System Description. The five SMOOS sensors: Temperature/Dewpoint, Cloud Height Indicator, Visibility/ Precipitation, Atmospheric Pressure and Sea Water Temperature were all tested. Each of these sensors is designed to measure and report certain environmental parameter(s) to describe the current state of the air/ocean environment. There are no hardware or software differences between the SMOOS sensors tested and those proposed for production.

3. Background. The SMOOS sensors were developed to provide the Tactical Environmental Support System (TESS(3)) afloat with accurate and timely local observations of appropriate air/ocean parameters to enable TESS(3) to integrate these data with environmental satellite and model output data received from other sources. This testing was performed as required by SMOOS OR No. 058-006-86. Previous development tests were conducted aboard USS THEODORE ROOSEVELT (CVN 71) and the sensor suite was utilized in an operational environment when the ship deployed in support of Desert Storm. During the earlier tests, problems were experienced on both the Visibility/Precipitation sensor and the Temperature/Dew Point sensor. These problems have been resolved and are the subject of DT-IIE.

4. Scope.

a. Objective. The overall objective of this DEVELOPMENTAL TEST was to determine the operational effectiveness and suitability of the SMOOS sensors during operation in a shipboard environment as documented in reference (a).

b. Evaluation Criteria. The key element of SMOOS is the ability of the sensors to continuously and objectively measure and update the parameters listed below in Table I and automatically record special observations required by rapidly changing environmental conditions. Therefore, during the test, environmental parameters measured by the sensors were compared with the ship's manually derived meteorological observations. Past problems, as noted above, were remedied by new alignment procedures and design changes. These procedures and design changes were provided by the OEM contractor to Lockheed and functionally tested at Lockheed prior to DT-IIE. Table I below shows the location on the ship of each of the five sensors and the parameter that each sensor is designed to measure. An additional objective of the testing was to assess the SMOOS sensors ability to perform in the harsh at-sea environment.

Sensor	Parameter Measured	Location Aboard CVN 71
Temp/Dew Point	Air temperature	FWD Port Catwalk
Temp/Dew Point	Dew Point temperature	FWD Port Catwalk
Cloud Height Indicator	Cloud Height	010 AFT Signal Br.
Visibility/Precipitation	Visibility	010 STBD FWD
Visibility/Precipitation	Precipitation rate	010 STBD FWD
Atmospheric Pressure	Atmospheric pressure	Met/Ocean Office
Sea Water Temperature	Sea water temperature	A/C Intake

Table I.

c. Limitations to Scope. This DEVELOPMENTAL TEST was not intended to verify the accuracy of the individual sensor measurements. The accuracy of the sensors has been established under controlled conditions after calibration, as part of the original sensor acceptance testing. Attempts to do this type of sensor evaluation at sea are unreliable due to variations expected in sensor performance, including, but not limited to, the various locations of SMOOS sensors, the time average measurements, and the higher accuracy of the SMOOS sensors over manual estimates in the case of cloud height and visibility, and the less accurate manually read dry bulb/wet bulb and pressure sensors.

5. Test Conduct. This DEVELOPMENT TEST was conducted by SPAWAR (PMW 165) and USS THEODORE ROOSEVELT (CVN 71) personnel at sea, around the clock, from 7 August 1992 through 21 August 1992. For evaluation purposes, SMOOS operated continuously from the 071455Z AUG observation through the 212355Z AUG observation. Total time for data comparison was 345 hours during which 472 manual observations were compared with SMOOS observations.

6. Results.

a. Effectiveness:

-Temperature and Dew Point Temperature (T/DP) Sensor. The T/DP sensor operated throughout the test period. An objective analysis of the collected data showed that manually observed and computed temperature and dew point were comparable to that reported by the SMOOS sensor. When possible, at least four daily observations were taken on the flight deck adjacent to the SMOOS sensor in addition to the observation taken at the 010 level. All these readings were within one degree of SMOOS readings. BIT tests taken throughout DT-IIE reported "Passed" on all checks. The only action taken on the sensor during this period was an adjustment to the fan failure potentiometer that eliminated a sporadic erroneous fan failure indication.

-Visibility. The visibility sensor operated throughout the test period. From 11 through 18 August reduced visibility was experienced. The visibility sensor reported a one minute average for visibility at the site of the sensor. Numerous times SMOOS recorded specials due to the rapidly changing visibility caused by variations in the rainfall amount. There were no instances where the observer logged five miles or less visibility and SMOOS hadn't also reported a decreased visibility. On one occasion visibility of 10 miles was shown with a rain rate of 1mm per hour. Trouble Report # G-003 was written on this minor software discrepancy for Lockheed's action.

-Precipitation. There were no problems with the precipitation sensor values. The sensor appears to have detected rain every time it occurred during the test period. Any time the observer had listed rain, SMOOS had recorded or was recording rain, and several times SMOOS reported rain that was missed by the observer due to the short duration and time of occurrence. SMOOS reported the time of onset of rain, reported the one minute rain rate throughout the duration of the rain. It did not report the time of rain cessation. Trouble Report # G-004 was written on this minor software discrepancy for Lockheed's action.

-Cloud Height Indicator. The cloud height indicator failed during this test period (Trouble Report # G-001 written). Voltage spikes and "brown outs" experienced by the ship during an electrical storm two nights prior to the ship's departure are suspected to have caused this failure. It is important to note that the cloud height indicator had already passed previous development tests. This fact, combined with its flawless performance during a six month USS THEODORE ROOSEVELT deployment in support of Desert Storm, demonstrates that the failure experienced during DT-IIE was an anomaly.

-Atmospheric Pressure. There were no problems with the atmospheric pressure sensor values. The sensor has performed flawlessly throughout all the developmental tests. We do, however, need to check the algorithm for density altitude. It appears that SMOOS consistently computes a lower density altitude than what is computed using the manual Density Altitude Computer.

-Sea Water Temperature. There were no problems with the sea water temperature sensor values. The sensor worked throughout the entire developmental test. A Fiber Optic Modem (FOM) interface to the coupler located at the sensor failed on 16 August causing data loss to the video display. It was replaced on 20 August.

b. Suitability:

-Hardware. During DT-IIE, two sensors experienced hardware failures. The Cloud Height Indicator failed due to power level problems suspected to be in the 20 volt unregulated power source. The sea water temperature sensor FOM failed and kept the sensor from reporting its raw data to TESS(3) and ultimately to the video display. The FOM was replaced for sea water temperature. However, due to the lack of spares for the cloud height sensor (the Navy only bought two cloud height systems and one was damaged during the required MIL-STD 901C shock test), there were no spares available for the cloud height sensor during DT-IIE.

-Software. No terminal hangs occurred when performing System Inquiry functions for SMOOS. The remote display reported a wind gust with proper direction but showed a speed of 0 knots. Trouble Report # G-002 was written on this minor discrepancy for Lockheed's action.

-Reliability, Maintainability, and Availability. Based on previous development tests and successful use of the sensors in an operational environment from 28 December 1991 to 3 July 1992 (Desert Storm), during which period no down time was experienced for any of the sensors, reliability, maintainability and availability have already been proven. The Temperature/Dew Point and Visibility/Precipitation sensors required a redesign and new calibration procedures, respectively, to correct erroneous readings. These corrections were made and were validated during this DEVELOPMENT TEST. Both of these sensors operated flawlessly.

7. Conclusions. This DEVELOPMENT TEST, combined with previous testing and actual operational experience, confirms that all SMOOS sensors can effectively support Navy operations. The cloud height sensor and sea water temperature sensor FOM malfunctions are minor problems in view of the fact that they had operated with no problems over the past two years during previous development tests and USS THEODORE ROOSEVELT's deployment in support of Desert Storm. The reasons for the past two developmental tests, as noted in DT-IIB, were for a calibration correction to the Visibility/Precipitation sensor and a design correction to the Temperature/Dew Point sensor. During DT-IIB, both the Temperature/Dew Point and Visibility/ Precipitation sensors operated perfectly.

8. Recommendations. On the basis of this DEVELOPMENT TEST and previous testing performed aboard USS THEODORE ROOSEVELT over the past two years, recommend the procurement of all five SMOOS sensors. Existing fixed price contract options are available through 31 December 1992 for procurement of all five SMOOS sensors in quantities consistent with current fleet requirements.

Joseph J. Miller

Test Director
Code PMW165-13, SPAWAR
Date: 9 October 1992

Program Manager
Code PMW165, SPAWAR
Date: 9 October 1992